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SHORT COMMUNICATION

The influence of motivation on stress: is it stressful not to fit?

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Abstract

The present research elaborates on the regulatory fit hypothesis by investigating a biological stress marker in a motivational fit- and non-fit-situation. Recent stress theories lead to the assumption that the participants' stress level in fit-situations remains constant or rather decreases, whereas under non-fit-conditions an increase of the stress activity is observed. We tested this hypothesis by assessment of salivary α-amylase (sAA), a saliva-based stress marker presumed to reflect noradrenergic activity. The results indicated that participants in a fit-situation show a decrease in sAA, whereas participants in a non-fit-situation demonstrate a contrary effect with an increase in sAA. These findings extend the concept of regulatory fit by illustrating that there are differences in sAA activity depending on whether participants are in a fit-situation. The experience of regulatory fit appears to be associated with a reduction of stress.

Keywords

α-Amylase, motivation, stress

History

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Introduction

The hedonic principle states that people are motivated to approach pleasure and avoid pain (Higgins, 1997). However, this assertion is not able to explain how people approach desired end states and avoid undesired end states in different strategic ways (Förster et al., 1998). The regulatory focus theory (RFT) incorporates the hedonic principle, but differs in its treatment of motivational consequences (Higgins, 1997). Thus, the RFT proposes two modes of self-regulation, a promotion focus centered on accomplishments and aspirations and a prevention focus with a focus on safety and responsibilities. Promotion-oriented individuals search for ideal goals and represent their goals as gain/non-gain, whereas prevention-oriented individuals search for duty goals and represent their goals as non-loss/loss. According to this theory, individuals experience regulatory ''fit'' when the task requirement and the chronic, regulatory focus of a person (e.g. in an anagram-task or math-test) is enhanced and motivation to perform the task is higher (Förster et al., 1998; Higgins & Spiegel, 2004; Keller & Bless, 2006). In addition, previous findings in sports showed that in the right ''fit'' exists between personality and task-framing, more goals were scored in a penalty kick scenario (Plessner et al., 2009).

Most previous studies demonstrate that a regulatory fit in motor and cognitive tasks will lead to performance improvements. However, it remains unclear which neurobiological mechanism could lie behind this fit-benefit. Higgins & Spiegel (2004) assume that an increased motivational intensity can translate into superior goal-performance and Higgins (2000) postulates that an increased task-enjoyment and an extended intrinsic motivation cause this fit-effect. Or could stress as a physiological parameter be a potential mediator to explain the better performances in motivational fit-situations? The aim of the present study was to examine if physiological stress responses, especially the activation of the sympathetic nervous system (SNS), could explain the enhanced performance in motivational fit-situations. Such a relationship between motivational fit and stress has not been examined yet.

Recent stress theories suggest that work performance and stress have a negative linear relationship, that is, performance decrease is related to high stress levels (see Edwards et al., 2007). Emotional arousal and stress lead to a rapid activation of the SNS. SNS activity in turn can have an impact on the function of the prefrontal cortex (see work and review by Arnsten, 2009) and could thus be an important mediator in explaining some of the negative cognitive and affective consequences of being in a non-fit-environment. To measure stress, one promising marker is salivary α-amylase (sAA), an index for stress-induced activity of the SNS (Rohleder & Nater, 2009). Previous findings indicate a correlation between sAA and noradrenaline (Nater & Rohleder, 2009; Rohleder & Nater, 2009). Moreover, stress-induced increases in sAA could be blocked with the beta blocker propranolol (van Stegeren et al., 2006), whereas administration of yohimbine leads to an increase of sAA concentrations (Ehlert et al., 2006). Another study showed that in situations of psychological stress, sAA increase is provoked (Rohleder et al., 2006). Furthermore, sAA responds to stress immediately and without great time delay (Strahler, 2012) in comparison to cortisol, which is an essential fact for the design of this study.

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SAA, thus, appears to be a reliable, simple, saliva-based indirect marker of the SNS-activity (Nater & Rohleder, 2009; Rohleder & Nater, 2009).

This study was designed to investigate sAA responses under two different conditions, namely in a fit- and a non-fit-situation with the help of a common paper pencil task by Friedman and Förster (2001). We hypothesize that the participants' stress level in fit-situations should remain constant or rather decrease, whereas under non-fit-conditions an increased activity of the stress systems will be observed.

Method

Participants

Sixty-four male college students ($M = 24.29$ years, $SD = 3.12$) took part voluntarily in the experiment. A written informed consent was obtained from every participant before commencing the experiment. The study was carried out in accordance with the Helsinki Declaration of 1975 and was approved by the Institutional Review Board of the local university.

Materials and design

Within a 3 (measuring points) × 2 (fit- vs. non-fit-group) design, participants received a classic procedural priming task for an experimental manipulation of the regulatory focus (Friedman & Förster, 2001). They had to either solve the promotion (cheese maze) or the prevention (owl maze) manipulation between the first and the second saliva sample. Managing the cheese maze activates a concept of focus on accomplishments, whereas figuring out the owl maze displays a concept of focus on safety (Friedman & Förster, 2005). The chronic, regulatory focus of each participant was measured with a German version of the regulatory focus questionnaire by Lockwood et al. (2002), which has already been used successfully to investigate regulatory fit-effects in previous studies (Keller & Bless, 2006). The dependent variables were the measured sAA activities at the three measuring points (MPs). Especially the differences between MP 1 and the two other MPs were used as markers of individual stress reactivity.

Procedure

In advance, the participants were told that 1 h before the beginning of the study they should neither smoke, nor drink juice or coffee, nor have a big meal (for an overview, see Rohleder & Nater, 2009). They arrived individually between 10 and 12 o'clock in the morning for the experiment. Prior to the start of the experiment they filled out the informed consent sheet and a questionnaire concerning some personal data. Afterwards, they had to complete the regulatory focus questionnaire from Keller & Bless (2006), in order for us to measure the participants' regulatory focus. Then, 10 min after their arrival, the participants supplied a saliva sample to determine baseline sAA levels with the help of a salivette sampling device. Rohleder et al. (2006) reported that valid measurements of sAA can be obtained using salivettes without the need for an assessment of flow rate. In addition, they found that there are no differences concerning the relative increases of sAA in saliva obtained by salivettes versus passive drooling. Rohleder & Nater (2009) summarized that for saliva sampling, salivettes and passive drooling are both equally well suited. This saliva collection lasted 30 s for each saliva sample and participants were instructed to chew on the salivette.

Afterwards, the participants completed five mazes primarily either leading a mouse toward the cheese (promotion manipulation: ''Guide the mouse to the cheese'') or away from an owl (prevention manipulation: ''Save the mouse from the owl''). To extend the period working with the mazes, they were given either 10 promotion or prevention mazes in total. After the first set of five different and randomized mazes, they got another task to distract them for some time from their actual maze task. They had to color two pictures by numbers before they continued their last five mazes. These last five mazes were the same as the first five ones, but in a different order. Following these tasks, we collected the second salivary sample from the participants (about 10–15 min after the first one). Afterwards, the participants had to answer some questions about their liking and the perceived difficulty of the tasks, as well as about their motivation to perform the tasks (Friedman & Förster, 2005). Finally, 5 min after the second saliva sample, they had to supply a third and final sample.

Overall, the participants had to supply three saliva samples and had to solve either 10 cheese maze tasks (promotion manipulation) or 10 owl maze tasks (prevention manipulation). With the help of a median-split, we divided our sample into a relative promotion focus group and a relative prevention focus group (for a similar procedure, see Keller & Bless, 2006), depending on their chronic, regulatory focus. Together with the experimental-task manipulation this created two groups: a fit-group and a non-fit-group.

Data analysis

We ran a univariate analysis of variance (ANOVA) to examine the effects on motivation and stress. The two groups (fit vs. non-fit) were a between subject factor and the three MPs were entered as repeated-measures factor since they were measured within-subjects. Whenever the assumption of sphericity was violated, the p-values for the interaction and the main effects were computed using the conservative Greenhouse–Geisser method with corrected degrees of freedom. The stress-induced increases or decreases of the sAA activity were specified for each participant as two delta scores by subtracting the baseline value (MP 1) from both MP 2 and MP 3 (Strahler, 2012). Hence, a negative score represents a decline of the sAA activity and a positive value represents an increase of the stress activity.

Finally, we computed a correlation between the z-standardized values of the relative regulatory focus indices and the delta scores from the MPs. We multiplied these z-standardized values with -1 for the prevention task and $+1$ for the promotion task. Thus, participants with higher positive scores are more in a fit-situation and participants with higher negative scores are more in a non-fit-situation.

Results

The analysis of the internal consistency yielded a satisfactory consistency for the promotion scale ($\alpha = 0.73$) and for the prevention scale ($\alpha = 0.70$) as a reliable measure of the regulatory focus questionnaire (Keller & Bless, 2006). The mean of the promotion index was 4.81 (SD = 0.82), the mean of the prevention index was 3.30 (SD = 0.83).

Since Mauchly's test revealed violations of the sphericity assumption for the factor MP, $\chi^2(2) = 12.010$, $p = 0.002$, we used adjusted degrees of freedom based on the Greenhouse–Geisser correction. For these and other analyses in which the sphericity assumption was violated, we reported the value of ε from the Greenhouse–Geisser correction. A 3 (MP) × 2 (fit- and non-fit-group) ANOVA on stress-induced arousal revealed a significant interaction effect, $F(2, 116) = 4.675$, $p < 0.05$, $\eta_p^2 = 0.075$, but neither a significant main effect of MP, $F(1.681, 97.480) = 0.394$, $p = 0.640$, $\eta_p^2 = 0.007$, $\varepsilon = 0.840$, nor of group, $F(1, 58) = 0.302$, $p = 0.585$, $\eta_p^2 = 0.005$. Under the non-fit-condition there was an increase of the sAA level from MP 1 to MP 2 and 3. In contrast, the fit-group presented the expected decrease. There were significant differences both at the difference scores from MP 1 to MP 2, $t(1, 58) = -2.540$, $p < 0.05$, and as well as at the difference scores from MP 1 to MP 3, $t(1, 58) = -2.278$, $p < 0.05$ (Figure 1).

When defining fit- vs. non-fit groups as 33% of the highest vs. the 33% of the lowest delta scores (cf. MacCallum et al., 2002) and task framing, respectively, we did not find a significant interaction effect on stress induced arousal ($p = 0.116$) and we did not find significant differences at the sAA delta scores (MP 1 to 2, $p = 0.078$; MP 1 to 3, $p = 0.094$), but a clear trend similar to Figure 1 could be demonstrated. Reasons for this might be a loss of power, because 33% of our participants dropped out of the study.

A correlation between the z-standardized values of the relative regulatory focus indices and the delta scores from MP1 to MP2 revealed a significant, expected negative correlation ($r = -0.249$, $p < 0.05$ (one tailed)). Thus, there was a correlation with decreasing sAA levels of the relative fit-participants and an anticipated increasing stress activity of the relative non-fit-participants (Figure 2). Another correlation between the z-standardized values of the relative regulatory focus indices and the task enjoyment showed a clear trend for the expected positive correlation ($r = 0.181$, $p = 0.076$ (one tailed)) and a correlation between the z-standardized values of the relative regulatory focus indices and the motivation ($r = 0.219$, $p < 0.05$ (one tailed)) demonstrated a significant, expected positive correlation. Participants are more motivated when being in a relative fit-situation compared to a relative non-fit-situation. This positive correlation occurs especially for higher motivation values.

Discussion

The aim of the present study was to investigate stress as an underlying mechanism of regulatory fit. Stress was measured with sAA, a presumed indirect marker of the SNS activity (Nater & Rohleder, 2009; Rohleder & Nater, 2009). Our data indicate that the SNS was influenced by a motivational task: sAA activity of participants in a fit-situation decreased, while it increased in a non-fit-situation. This could be demonstrated using a median split as well as a correlational approach. Differential effects on the SNS could be seen as a possible mediator to explain the benefits of a fit-situation in contrast to a non-fit-situation.

Future research designs should try to replicate these findings (Cumming, 2014; Lakens & Evers, 2014; Simmons et al., 2011) with the help of cognitive and motor performance tasks that have already been used under regulatory fit-aspects (Shah et al., 1998). In such a replication study one could use the Keller & Bless (2006) questionnaire (German version of the general regulatory focus measure by Lockwood et al., 2002) as well as the regulatory focus questionnaire developed by Higgins et al. (2001) to measure the chronic regulatory focus of the participants. With different tasks and

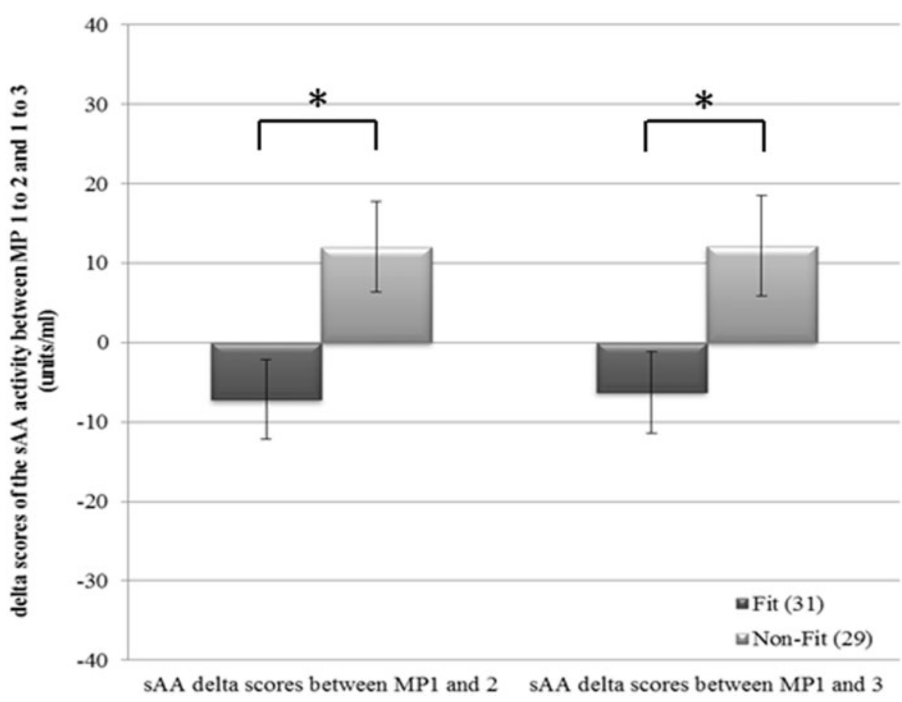

Figure 1. Differences of the sAA activity with SEM between MPs 1 and 2 and between MPs 1 and 3. Participants in a fit condition showed a decrease in sAA concentrations, in contrast participants in a non-fit condition displayed increased sAA concentrations.

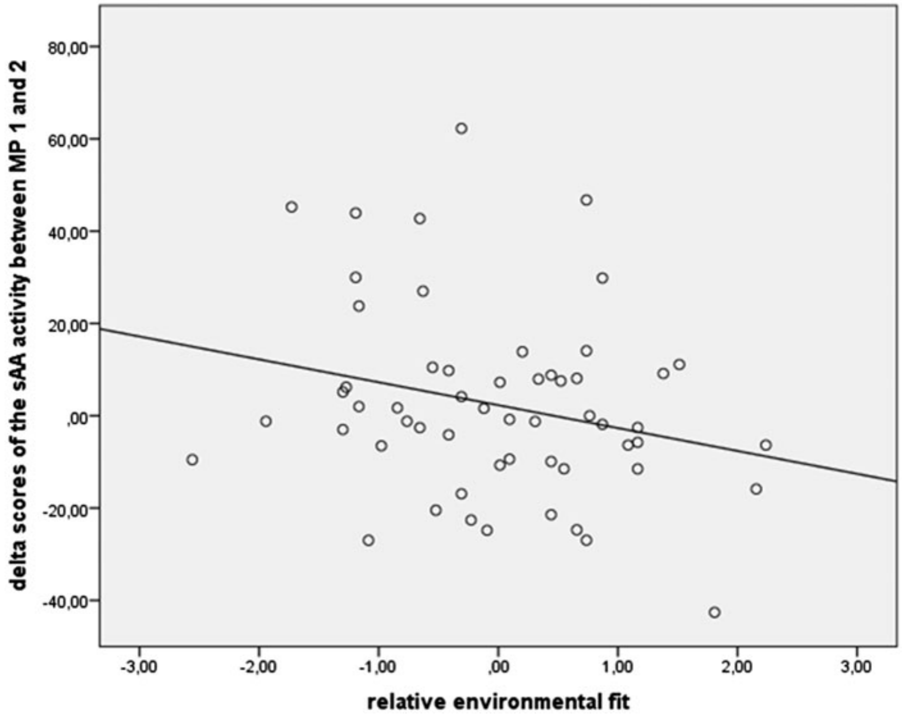

Figure 2. Correlation between the sAA response to the task (delta scores of the sAA activity between MPs 1 and 2) and the relative environmental fit (positive *z* values indicate a fit situation whereas negative *z* values indicate a non-fit situation).

questionnaires, it would be possible to evaluate whether participants under fit-conditions perform better than participants under non-fit-conditions, along with determining sAA activity of participants in a fit-situation decreases versus that of participants in a non-fit-situation.

This possible decline (or stagnancy) could be the reason for better performance in a fit-situation, and the mentioned rise of the sAA activity could explain the reduced performance during a non-fit-situation. To test this assumption, one could compare the performance of different task levels between the fit- and the non-fit-group and the respective sAA activity to enable clearer conclusions about the relationship among motivation, stress and performance.

Nevertheless, we would expect that any kind of stress reduces attention or energy from any task at hand and consequently inhibits performance, as for example the functions of the prefrontal cortex (e.g. cognitive control or goal-oriented action) (Arnsten, 2009).

Limitations of the present study

In the current study we used sAA as a presumed indirect marker of SNS activity (Nater & Rohleder, 2009; Rohleder & Nater, 2009). This marker, however, has been criticized for its intermixture of parasympathetic aspects (Bosch et al., 2011) and for its potential reliance on sampling issues like flow rate (Bosch et al., 2011; but see Rohleder et al., 2006). Future studies on this topic should consider using other SNS markers like heart rate and its variability to obtain additional support for increased SNS activation in situations of motivational non-fit.

Furthermore, we acknowledge that power was limited for running the highest versus lowest delta scores analysis. In our study, 33% of our participants dropped out; attrition rate should be taken into consideration when planning future research.

Conclusion

In summary, our study suggests that being in a fit-situation is associated with reduced stress (reduced sAA levels), whereas being in a non-fit-situation is clearly stress-inducing. Building on common stress models that state that a decline of stress could, for example, reduce cardiovascular diseases, an effort should be made to give people tasks that fit their motivational orientation and, thus, lead to a regulatory fit. In the working world this pursuit could lead to attuning the regulatory focus of the workers to the working environment in order to reduce the work-related stress and its consequences.

Declaration of interest

The authors report no conflict of interest. The authors alone are responsible for the content and writing of the paper.

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